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TSAR/DYNA-METRIC GRAPHICS AND STATISTICAL PROCESSORS: EXECUTIVE SUMMARY

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The Theater Simulation of Airbase Resources (TSAR)/Dyna-METRIC Graphics and Statistical Post-Processors facilitate the handling of output data generated by the following models, and their presentation into graphical representations: TSAR, Version III; TSAR Inputs using AIDA (Airbase Damage Assessment) (TSARINA), Version III; and Dyna-METRIC, Version 4.4. The Statistical Processor was developed and tailored to the TSAR and Dyna-METRIC models to allow for limited statistical assessment of variables associated with the models.

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SUMMARY

The Theater Simulation of Airbase Resources (TSAR)/Dyna-METRIC Graphics and Statistical Post-Processors facilitate the handling of output data generated by the following models, and their presentation into graphical representations: TSAR, Version III; TSAR Inputs using AIDA (Airbase Damage Assessment) (TSARINA), Version III; and Dyna-METRIC, Version 4.4. The Statistical Processor was developed and tailored to the TSAR and Dyna-METRIC models to allow for limited statistical assessment of variables associated with the models.

PREFACE

This paper was prepared by Ball Systems Engineering Division as an Executive Summary of the work performed in developing the Theater Simulation of Airbases Resources (TSAR)/Dyna-METRIC (Dynamic Multi-Echelon Technique for Recoverable Item Control) Graphics Post-Processor and Statistical Processor. The work was accomplished for the Air Force Human Resources Laboratory, Logistics and Human Systems Division, Wright-Patterson Air Force Base, Ohio, under Contract Number F33615-87-C-0016 (Work Unit 1710-00-46). This work was conducted as part of the Laboratory's overall effort to enhance the analytic tools already available to the analyst and to increase the efficiency of the logistics analysis process. The period of performance was 29 May 1987 to 10 February 1989. The USAF Program Monitors were Richard E. Lamb and Janet L. Peasant.

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I. INTRODUCTION

The TSAR (Theater Simulation of Airbase Resources), TSARINA (TSAR Inputs Using Airbase Damage Assessment, and Dyna-METRIC (Dynamic Multi-Echelon Technique for Recoverable Item Control) mainframe models are used to assess airbase operations and quantify wartime resource requirements and interactions throughout the DoD community. These models, however, lack user-definable graphical representation of output data.

Although TSAR does provide the user with an extensive output, it is difficult and time-consuming to sort out useful information. Much of the output is not well documented and, if documentation is available, the output often requires cross-referencing with the manuals for interpretation. The major portion of a TSAR output listing is tabular in nature and written along the simulated timeline of a given scenario with inadequate summary statistics. The identification of trends and comparison of results require a significant amount of data extraction and manipulation.

The TSARINA model, a companion program to TSAR, is used to provide measures of damages and resource losses due to conventional and chemical attacks to the airbases modeled in TSAR. The main output file from TSARINA is tabular and summarizes damages to each base facility. TSARINA also prepares files for input to TSAR such as measures of damage loss to buildings and resources on each base. If chemical attacks are simulated, another transitional file provides measures of chemical agent levels at monitoring points about each base. As with the TSAR model, much of the output of the TSARINA model lacks adequate documentation. In cases where documentation does exist, cross-referencing with the manuals for interpretation is still necessary.

Although Dyna-METRIC is an analytical model rather than a Monte Carlo simulation, output from Dyna-METRIC is also presented in tabular form for each day of a given scenario. The identification of trends as a function of time requires data extraction and input to an external graphics package. Though the manual for Dyna-METRIC shows all of its output comparisons in the form of curves, the model itself provides only rudimentary graphics.

To extend the management utility of the TSAR and Dyna-METRIC models, Ball Systems Engineering Division (BSED) has developed integrated output data management software that performs all of the data manipulations necessary to provide the user with flexible graphical representation capability. Additionally, within the same graphics software programs developed for TSAR and Dyna-METRIC, the capability to obtain graphical representation of the TSARINA base layouts showing chemical and conventional weapons effects patterns has also been provided.

During typical TSAR and Dyna-METRIC runs, significant portions of analysis are conducted using limited statistical "measures" which consist primarily of the mean or average value as computed over a given number of trials. However, the mean value is not always a reliable indicator of the characteristics of the data being assessed. One or two outlying values, for example, may provide a mean which is deceivingly biased (i.e., either too small or too large). In such cases, it is useful to employ additional

measures, such as higher moment generation and Analysis of Variance (ANOVA), which may give better insight into the true nature of the data. Hence, a BSED-developed TSAR/Dyna-METRIC Statistical Processor (TDSP) has also been provided.

Section II provides an executive overview of the TSAR/Dyna-METRIC Graphics and Statistical Processors. Section III provides Conclusions and Recommendations.

II. TSAR/DYNA-METRIC GRAPHICS AND STATISTICAL PROCESSORS

TSAR Dyna-METRIC Graphics and Statistical Processors were developed in three different modules: TSAR Output Scanner (TOSCAN) program, TSAR/Dyna-METRIC Plotting (TDPLOT) program, and TSAR/Dyna-METRIC Statistical Processor (TDSP) program. The TOSCAN module condenses TSAR output files for later use in TDPLOT. TDPLOT creates the plots. The TDSP performs higher-level statistics. The overall design for the TSAR/Dyna-METRIC Graphic and Statistical Processors is depicted in Figure 1 and described below.

The Programmer's Manual for the TSAR/Dyna-METRIC Graphics and Statistical Processors[1] provides documentation for the TOSCAN, TDPLOT and TDSP programs in sufficient detail to allow programmers and analysts to understand, maintain, use, and revise the code.

The User's Manual for the TSAR/Dyna-METRIC Graphics and Statistical Processors[2] documents TOSCAN, TDPLOT and TDSP program input, operation and output. This manual is intended for use by personnel who are not programmers, and it should provide sufficient guidance for operation.

TSAR/Dyna-METRIC Graphics Post-Processor

The graphics portion of TSAR/Dyna-METRIC Graphics and Statistical Processors is comprised of two of the three modules mentioned above. The first module, TOSCAN, is an auxiliary interface program that accompanies TDPLOT. The TOSCAN module is hosted on the same computer as TSAR. The second module is the graphics generation module, TDPLOT, which is to be hosted on an IBM PC/XT, PC/AT or compatible microcomputer.

TOSCAN Program

The purpose of TOSCAN is to scan TSAR output files and produce a readable summary output file for later use with TDPLOT.

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[1]Ball Systems Engineering Division. (1988, December). The Programmer's Manual for the TSAR/Dyna-METRIC Graphics and Statistical Processors. San Diego, CA.

[2]Ball Systems Engineering Division. (1988, December). The User's Manual for the TSAR/Dyna-METRIC Graphics and Statistical Processors. San Diego, CA.

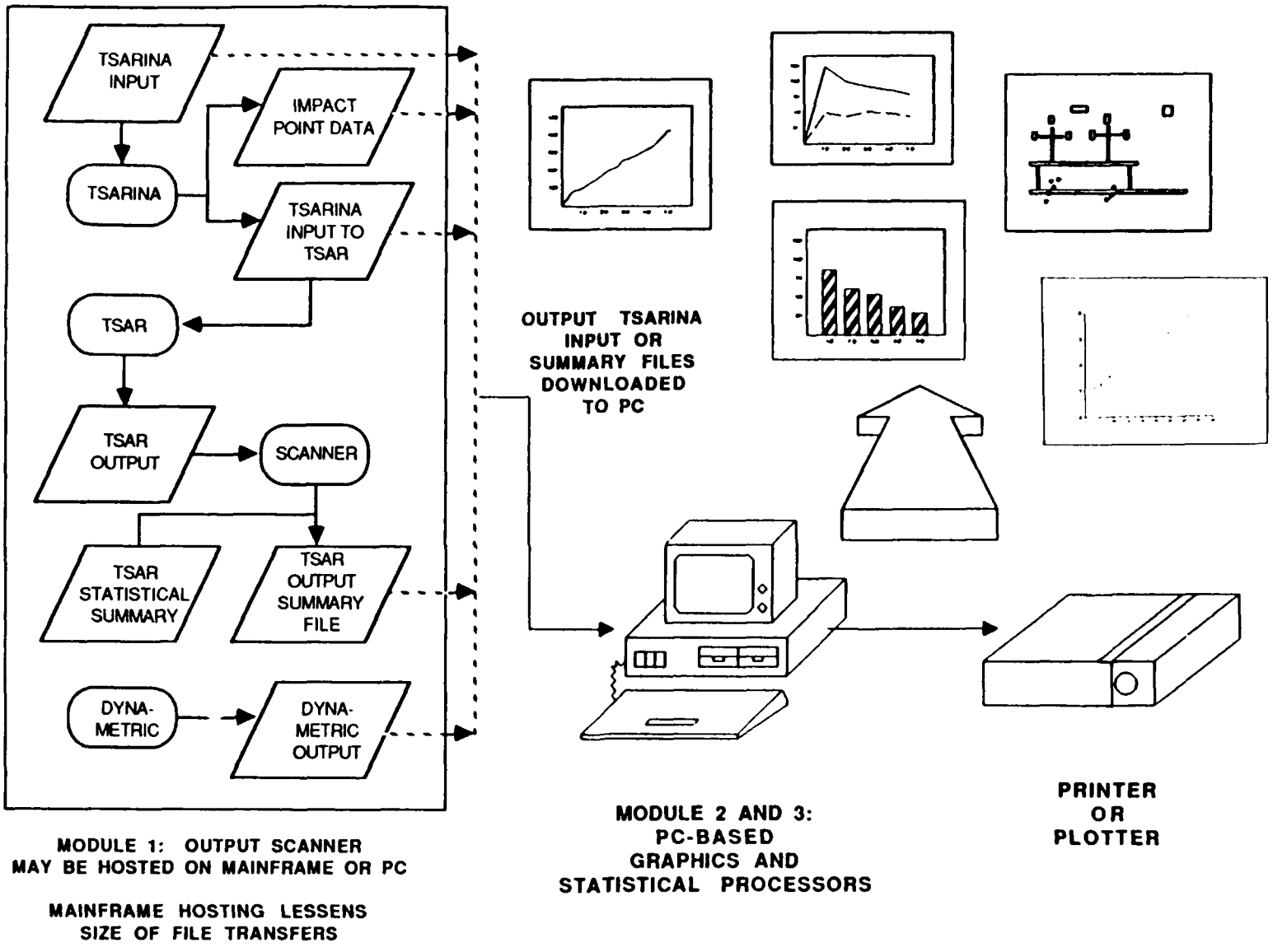

Figure 1. TSAR Dyna/METRIC Graphics and Statistical Processors Overall Design.

TOSCAN has the capability to condense very large output files (e.g., 20 repetitions that amount to 4 or more inches of output file) to summary files that are no more than 10% of the original TSAR output file size. These summary files are much easier to use than the original TSAR output files when comparisons of several TSAR simulation runs are to be made.

TOSCAN also provides in a single, concise table format additional summaries that are not available in the original TSAR output (such as the number of personnel expected to return to production after exposure to a chemical attack and attack summaries). Should the user so desire, TOSCAN will also create a readable statistical file that can later be used with the TDSP.

TDPLOT Program

The purpose of TDPLOT is to extract graphics data from the TSAR summarized output file, the input and output TSARINA files and Dyna-METRIC output files; to facilitate visual display to the CRT; and to transfer the graphical data extracted to printing or plotting devices.

TDPLOT was designed with a menu-driven interface that provides the ability to create plots from the data extracted from the aforementioned models -- with a minimum amount of effort and in a self-explanatory fashion in that the TDPLOT program provides on-line help. Hence, referencing of printed documentation for operational instruction is kept to a minimum.

TSAR output and input/output TSARINA and Dyna-METRIC files are downloaded to the PC via a user-supplied communications package. The user then selects his/her desired file and plot data for which to scan. From this point, the scanning process is automatic and the user is notified via screen messages as to the progress of the scan.

TDPLOT provides a large selection of TSAR and Dyna-METRIC plots from which to choose and combine. The plots available to the user are those preferred by the TSAR, TSARINA, and Dyna-METRIC user community that participated in the Phase I, TSAR/Dyna-METRIC Graphics Post-Processor user surveys. A plot may be displayed as a line graph, histogram (i.e., bar chart), or pie chart.

In addition to the TSAR and Dyna-METRIC plots, plots may be created from user-defined data that have been entered at the keyboard or read from predefined files. This capability allows the user to create experimental or "what if?" plots which may be displayed alone or in combination with TSAR or Dyna-METRIC plots.

TSARINA resource loss and facility damage plots are also available via TDPLOT. These plots may be displayed in a line graph, histogram or pie chart format. Additionally, base element plots are also available as illustrated in Figure 2. As base element plot options the user may view the base elements after a conventional or chemical attack. A base element plot after a conventional attack might include weapon aimpoints or weapon impact points. A base element plot after a chemical attack might include chemical contour levels that would indicate areas of chemical concentration and/or vapor deposition levels, and/or markers depicting the chemical monitoring point

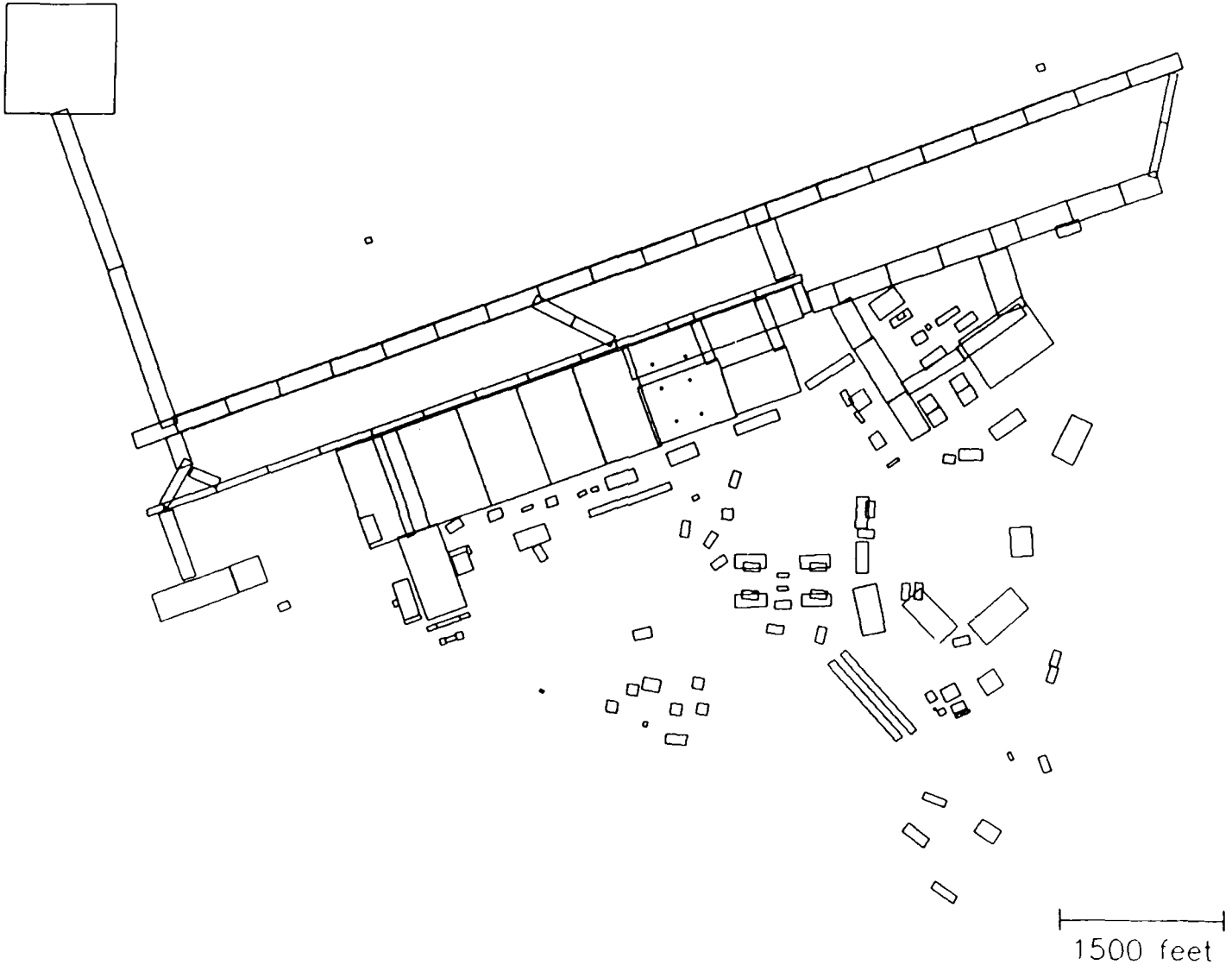

Figure 2. Base Element Plot.

locations. As an added feature, an interactive zoom feature is available for the TSARINA base element plots.

To facilitate the generation of TSARINA input sets, BSED has developed a digitization program, DGTBAS, that creates from airbase maps the formatted base element description cards or target (TGT) cards for the TSARINA input set. This program is an interactive menu-driven system which is a separate module from TDPLOT.

Some of the other capabilities of TDPLOT include: the ability to create statistical files on the PC to be later used with the TDSP, unattended printer or plotter batch modes, the ability to store or retrieve any plot with user-defined filenames, and a file manager.

The file manager is accessed directly via TDPLOT from every indentured level within TDPLOT. Its purpose is to allow users to organize their PC directories, select and retrieve existing files, and perform several DOS-like functions such as copy, rename and delete. It was designed to be easier to use than the DOS operating system.

The graphics subsystem of the TSAR/Dyna-METRIC Graphics Post-Processor is a BSED-developed, self-contained program that is embedded in TDPLOT. This program has one top-level entrance and exit point and is completely menu-driven. Once the user enters into the graphics system, he/she can: display any existing plot, customize every aspect of a plot via comprehensive editing capabilities, or route a graph to the printer and/or plotter.

If a user decides to modify a plot, all text (i.e., titles, legend labels, axis tick mark labels, etc.) may be changed. The font, size, and color of all text may be changed globally or individually with the aid of on-line help.

The graphics subsystem can support one or two main plot or axis titles, inner and outer bordering frames, and one or two Y-axes. The major and minor tick marks along the X- and/or Y-axis may be defined by the user; however, defaults are provided. The user also has the option to view the graph with $\log_{10}$ X- and/or Y-axis. If the data values are large and would be better represented with scientific notation, the graphics subsystem will automatically display the numeric labels along the X- and/or Y-axis in scientific notation. However, this feature may be overridden.

The graphics subsystem can display a plot, with or without a legend, as a line graph, histogram (i.e., bar chart) or pie chart. The same graph can be represented as a line graph, histogram or pie chart by a single menu modification. If the plot is displayed as a line graph, the line types may be varied; on-line help is available. If the plot is displayed as a histogram or pie chart, the fill types for the bars or slices, respectively, may be changed; on-line help is again available. The graphics subsystem also provides automatic rounding of data points for the X- and Y-axes. This feature may be overridden, or user-defined maximum values for the X- and Y-axes may be used.

Via the graphics subsystem, the user also has hardcopy options that control the size and location of the plotting area with respect to the legend

and with respect to the paper on which it is being printed and/or plotted. With these options, the user can display multiple plots on one sheet of paper.

TSAR/Dyna-METRIC Statistical Processor (TDSP)

The TSAR/Dyna-METRIC Statistical Processor (TDSP) module was developed as a functional module separate from the TOSCAN and TDPLOT modules. The TDSP is to be hosted on an IBM PC/XT, PC/AT or compatible microcomputer.

The purpose of the TDSP is to provide additional statistical measures that give greater insight into the true nature of the data extracted from the TSAR summary output file and Dyna-METRIC output files. The TDSP also facilitates visual display of tables (such as ANOVA tables) and graphs (such as bar charts) and permits the graphs to be plotted and/or printed.

The user interacts with the TDSP through a menu-driven system that allows the user to step through the statistical procedures that are to be performed on the data extracted from the TSAR and Dyna-METRIC models. The extracted data are managed by the TDSP.

The TDSP data management capability allows the user to process multiple data samples. From multiple data samples, the TDSP can produce an ANOVA table and a multidimensional regression analysis table. The regression models may be user-defined, utilizing a variety of implicit mathematical functions.

The TDSP provides several techniques for analyzing a single data sample. The density function representing the data samples can be estimated by using shape generation algorithms, or a density-fit and/or inspection of the histogram. The density can be evaluated using a chi-square test, t-test or moment generation.

The graphics subsystem also provides an embedded graphics capability in the TDSP program. It provides to the user the means to visually inspect histograms, densities, and the data sample. The user also has the option to view the graphical representation of the regression fit. A multiple plot graph allows densities and histograms to be compared.

III. CONCLUSIONS AND RECOMMENDATIONS

The TSAR/Dyna-METRIC Graphics and Statistical Post-Processors facilitate the application of the TSARINA/TSAR and Dyna-METRIC models. Major benefits to the user include a significant improvement in both interpretation and presentation of output data, and therefore increased efficiency. The software also provides an opportunity for expansion, as required.

The features and capabilities incorporated in the post-processors were based on the results of a survey conducted among major users of the TSARINA/TSAR and Dyna-METRIC models. As a result, the software is considered to be essentially complete. This does not, however, preclude the possibility that additional features may be identified in the future. The modular architecture of the software code will facilitate the incorporation of additional features.

Two basic recommendations for the TSAR/Dyna-METRIC Post-Processors are as follows:

1. Modification to allow incorporation of the post-processor software with the improved versions of TSARINA/TSAR released in calendar year 1988;

2. Collection and review of user evaluations and feedback to identify additional options, particularly for the Dyna-METRIC interface.